Efficiency Wages and Rent Sharing: A Note and Some Empirical Findings

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Abstract: Tests for the efficiency wages hypothesis have proposed to use production functions to ask if wages increase can pay for themselves. Tests for rent sharing have used a profit term in the earings function. In this note the relationship between these tests is investigated empirically. Evidence is presented for the Ghana manufacturing sector which allows a test discriminating between the two hypotheses to be conducted.

1. Introduction

Two major results in testing for efficiency wages using production functions are those of Wadhwani and Wall (1991) and Levine (1992), who find that relatively high wages in the firm are associated with high productivity. Another paper using a closely related approach is that of Konings and Walsh (1994), who seek to discriminate between the efficiency wage and rent sharing hypotheses by investigating the relationship between market shares and wages. They find evidence for rent sharing in highly unionised parts of the labour markets and for efficiency wages in the low unionised sector. The efficiency wage hypothesis is that firms can reduce costs by increasing wages; the rent sharing hypothesis is that employees are able to raise their wages by threats and that firms are compelled to share some of their profits with the employees. Wadhwani and Wall (1991) explicitly compare the efficiency wage explanation with that of rent sharing. Levine (1992) argues that, in many respects, the two classes of explanation are complementary. One example being that firms may "choose" to raise wages because of potential employee threats.

The results of Konings and Walsh (1994) suggest that both efficiency wages and rent sharing may be present in the labour market. In this paper a test is conducted of the relationship between the two theories. An earnings function, including a rent sharing term, is transformed into a productivity equation. The test relates to the size of the coefficient on the relative wage term in the productivity equation. It is shown that the two theories have radically different implications for the size of this coefficient. Relative wages, productivity and profits are simultaneously determined and any test must allow for this fact. A recent test of the rent-sharing hypothesis in Abowd and Lemieux (1993) argued that the size of the rent sharing parameter was greatly increased if instrumental variables allowed for the simultaneous equation bias present in the OLS estimation. A similar procedure is used in this paper. The data in this paper has information on whether the firm is unionised. It is therefore possible to follow both Wadhwani and Wall (1991) and Konings and Walsh (1994), in discriminating between the hypotheses by considering union and non-unionised firms separately.

In section 2 the proposed test is formulated. The data that is available to test the hypothesis is described in section 3. The results are reported in section 4 and a comparison with other studies is carried out in section 5. A final section concludes.

2. Efficiency Wages and Rent Sharing

The approach adopted by both Wadhwani and Wall (1991) and Levine (1992) is to estimate a constant returns to scale Cobb-Douglas production function with two inputs: effective labour (e^aL) and capital K:

(1) $$Y = (e^aL)^b K^{(1-b)} f \epsilon$$

This specification includes a firm-specific productivity factor that is invariant over time, f, and i.i.d. shocks to the production function, ϵ which is assumed to be uncorrelated with changes to a, L or K. Under the efficiency wage hypothesis this can be shown to yield the following equation, where firm fixed effects are allowed for by differencing:

$$(2) \qquad \Delta\, Ln\, Y/L = b\, \Delta\, ln\, Rel\,(w) + (1 - b)\, \Delta\, Ln\, K/L + \Delta\, \epsilon$$

where *Rel (w)* is the relative wage in the firm.

The key implication of this hypothesis, which is accepted by Levine (1992) but not by Wadhwani and Wall (1991), is that the coefficient on the relative wage term should be equal to the labour share parameter. Levine has data on a relative wage term.

> "The PIMS dataset is unique in having a question that relates relative, not absolute wage levels. [The relative wage variable used in this paper] is the level of average hourly compensation (including fringes and pensions) paid by this firm compared to its three largest competitors in the product market, controlling for occupation" (Levine (1992, p.1106).

Wadhwani and Wall (1991) use the firm wage relative to average industry wages. The alternative wage, therefore, only varies by firms in different industries. The data used by Levine are for some 2,000 strategic business units from approximately 250 large North American manufacturing companies. The data in the Wadhwani and Wall paper are from the published accounts of 219 UK manufacturing companies over the period 1972-82. Again the firms are large, average employment in 1982 was 6,046.

In this paper we estimate the relative wage by taking the actual firm wage relative to the wage predicted by the human capital characteristics of the workers in the firm. This is equivalent to assuming that firms would pay the predicted wage to employees of a given skill level in a competitive market. In so far as the actual wage is higher than the predicted wage in some firms than others the question becomes whether this is due to the productivity effect of higher wages or higher profits, which are a reflection of higher productivity, leading to higher wages from rent-sharing.

The hypothesis that wage determination can be understood as a process in which workers and firms bargain and that one element in the game is a measure of firm performance can be found in Blanchflower, Oswald and Garrett (1990), Nickell and Wadhwani (1990), Christofides and Oswald (1992), Abowd and Lemieux (1993), and Blanchflower, Oswald and Sanfey (1993). The equation that is estimated in the papers that test rent-sharing directly is of the form;

$$(3) \qquad Ln\, w = \beta_0 + \beta_1\, \pi/L + \beta_2\, w^e + \beta_3\, H + controls$$

where π/L is profits per employee and w^e is the exogenously available wage. *H* is the human capital variables which allow controls for different education and skills. In this paper we control for the years of education, age and tenure of the employees.

If the technology is Cobb-Douglas then the share parameter is given by, $b=wL/Y$. If profits per employee are defined as value-added less wages then we have:

$$\pi/L = Y/L - w = (1 - b)\, Y/L$$

If we rewrite the rent sharing equation in logs in order to make the comparison more direct, we have:

$$Ln\ w = \beta_0 + \beta_1\ Ln\ \pi/L + \beta_2\ Ln\ w^e + \beta_3 H + controls$$

and using the definition of profits per employee this equation can be written as:

$$(4) \qquad Ln\ w = \beta_0^* + \beta_1\ Ln\ Y/L + \beta_2\ Ln\ w^e + \beta_3\ H + controls$$

Equation (4) is similar to that estimated by Nickell and Wadhwani (1990). In order to set up a comparison between the two theories we transform equation (4) so that it is an equation for the relative wage of the firm. We write:

$$(5) \qquad Ln\ [w/(Predicted\ wage)] = \beta_0^* + \beta_1\ Ln\ Y/L + \beta_2\ Ln\ w^e + controls$$

where the *Predicted wage* is estimated simply from the human capital terms in the earnings regression.

Writing equation (5) as one which explains productivity, and differencing to allow for firm fixed effects, we have:

$$(6) \qquad \Delta\ Ln\ Y/L = \beta_0^*/\beta_1 + (1/\beta_1)\ \Delta\ Ln\ Rel\ (w) - \beta_2/\beta_1\ \Delta\ Ln\ w^e + \Delta\epsilon$$

where *Rel (w)* = actual to predicted wage.

If we had included the capital to labour ratio as a determinant of earnings, which could simply reflect the view that more capital intensive firms need more skilled labour, then equation (6) would be identical in form to that of equation (2). In distinguishing between the two equations the issue is one of causation. In the efficiency wage theory the causation runs from relative wages to productivity. In the rent sharing theory the causation is reversed, higher productivity leads to higher profits which leads to higher wages. The manner of proceeding in the present paper allows the methods of discriminating between the two theories to be advanced, in that, under the rent sharing hypothesis, the coefficient on the relative wage term in the productivity equation is the inverse of the elasticity of wages with respect to rents in the rent sharing equation.

3. The Data

In order to be able to test between rent-sharing and efficiency wages, data is required for both measures of relative wages and profits of the firm. The dataset used in this paper contains a measure of both these variables and, as it is a panel, it is possible to control for firm fixed effects. The data is drawn from a survey of 200 firms in Ghana's manufacturing sector carried out over three years. In each round of the survey a sample of workers in the firm were also interviewed. The employee data is used to construct a profile of the human capital endowments of the firms (the details of this procedure are given in the Appendix). These endowments include the average level of education, the average age and years of tenure of those employed. These variables are used to predict the wage that the firm should pay on the basis of the human capital characteristics of the workers. The relative wage term is the actual average firm level wage relative to this predicted wage. Profits are measured as value-added less wages. Table 1 presents the raw data for the key variables for the three waves of the data. The relative wage is highest in the first wave of the data at 19 per cent and lowest in the second wave at 6 per cent. The profits per employee variable has a large standard deviation and does not rise monotonically over the three waves of the survey.

As noted above, the issue separating the efficiency wage and rent-sharing theories is causation. Wadhwani and Wall (1991) consider this issue and use a liquidity variable as a determinant of wages which, they argue, can be omitted from the productivity equation. They argue that the firm's liquidity position affects a firm's probability of bankruptcy, and in a world where there is costly bankruptcy, this can reasonably be expected to influence wages. Their liquidity variable is measured as the ratio of total cash and equivalent to total current liabilities. We have experimented with a variety of variables reflecting the firms financial position; in the regressions reported below we use the amount of formal borrowing per employee. The results were not sensitive to which of the financial variables were used.

Over the period that the data was collected in Ghana a rather natural experiment for the theories was conducted. The nominal exchange rate was falling faster than the rise in the domestic price level; between 1991 and 1994 the nominal exchange rate fell by 160 per cent while the price level rose by 70 per cent. This macroeconomic effect had markedly different effects on firms in the sample as those which were intensive users of imported inputs saw their costs rise rapidly. We use the share of intermediate inputs in value-added as an instrument. The argument is that this exogenous macroeconomic shock will have an adverse effect on the profits of firms with high cost shares, and, under rent-sharing, this adverse profit effect will lower wages. We test for the validity of both the instruments in the estimated equations.

4. The Results

In this section the results of the tests to discriminate between the hypotheses are reported. The objective is to compare the labour share parameter from the production function with the coefficient on the relative wage term in the productivity equation. The efficiency wage hypothesis predicts they will be the same. The rent-sharing hypothesis predicts that the value on the relative wage term will be the inverse of the elasticity of relative wages with respect to profits. All the estimates allow for firm fixed effects. For both the productivity and relative wage equations both OLS and IV estimates are reported.

In Table 2 the results of estimating the production function for the firms in the sample is given. The production function is generalised to include the human capital terms. A test for the exclusion of the on-linear terms in capital and labour is reported, as is a test for the pooling of the three waves of the data. The data accepts pooling and that the non-linear terms are not jointly significantly different from zero. A comparison of Table 2 equations (1) and (2) shows that firm fixed effects are of importance for estimating the labour share parameter and the value of the coefficient falls from 0.84 to 0.54 in moving from the levels to the fixed effects regression.

Table 3 reports an OLS estimation of a productivity equation and the equation for the relative wage term. The rather remarkable finding for the productivity equation is that the coefficient on the relative wage term is very close indeed to the parameter estimate implied by the efficiency wage hypothesis. There is also, in Table 3, only a small difference between the levels estimation and the differenced one. The parameter on labour share estimate from Table 2 is 0.54, the parameter on the relative wage term in the productivity equation is 0.45; these are not significantly different and would appear to be a striking confirmation of the efficiency wage hypothesis. The firms in Ghana are very small by the standards of the ones in either the Levine or Wadhwani and Wall data sets. The result reported here, for Ghana, is virtually identical to that obtained by Levine for large US firms. The relative price equation in Table 3 shows an elasticity of relative wages with respect to profits per capita of 0.07 with the levels specification and 0.11 in the differenced equation.[1]

Before the results of Table 3 can be accepted as supporting the efficiency wage hypothesis it is necessary to allow for the simultaneity bias which arises from the joint determination of relative wages, profits and productivity. This is indeed the central problem faced by tests that seek to distinguish between the two hypotheses. In Table 4 the results of using the instruments set out above are presented. The key results are for the differenced equations which allow for the firm fixed effects. The coefficient on the profit term in the relative wage equation is 0.17; this is the elasticity of relative wages with respect to profits in a rent-sharing interpretation of the data. The inverse of this coefficient is 5.9. The estimated value of the parameter on the relative wage term in the productivity equation is 5.4. The result is exactly that predicted by the rent-sharing interpretation of the data. The implications of these regressions are that an OLS procedure leads to a downwards bias in the estimate of the elasticity of relative wages with respect to profits and a more serious downwards bias for the relative wage term in the estimated productivity equation.

Finally we consider whether these results for rent sharing differ between the unionised and non-unionised sector. The equations reported in Tables 3 and 4 were re-run for non-unionised firms only. While the standard errors in general increased there were no significant changes to the values of the coefficients. In particular the differenced IV estimate for the elasticity of relative wages with respect to profits was 0.19 and the coefficient on the relative wage term in the productivity equation was 5.6; for all purposes identical to the whole sample results. Rent-sharing is not confined to the unionised sector in this dataset.

5. A Comparison with Other Results

It is clearly important to ask how the results reported in this paper compare with other results that have been obtained. It has already been noted that the OLS result, that the share of labour in a Cobb-Douglas production function is the coefficient on the relative price term in the productivity equation, is identical to the result obtained by Levine (1992). Levine then tests for whether unionised firms differ from non-unionised ones. He find that:

[1]The use of logs excludes the firms with negative profits. If the regressions are re-run using the profit per employee term rather than logs the results are the same. We have reported estimation with logs as the results can be interpreted as an elasticity and it is the size of this elasticity which is crucial for the test proposed in this paper.

> "As predicted by efficiency-wage theories, the productivity effects of high wages are smaller in unionised settings than in non-union settings." (p.1109)

He notes that this result mitigates against the rent-sharing hypothesis. The findings above (that the result was at least as strong for the non-unionised sector) directly conflict not only with the Levine (1992) result but also the results reported by Konings and Walsh (1994). However, there is evidence cited in Oswald (1995) which does find a rent sharing effect in the private sector similar to that reported in this paper. The point needs to be made that it is quite possible that the labour market analysed in this paper will perform differently from the US and UK labour markets, which are the basis of all these studies. The manufacturing sector in Ghana is very small. Firms of very modest size, by UK or US standards, are large relative to the median in Ghana.

The second aspects of the findings in this paper is that the size of the rent sharing effect is greatly increased if the profit term is instrumented. This result is common to all papers which have used instruments other than lagged values of the variables (Oswald 1995). This may reasonably lead to doubts about the value of the instruments but the results in this paper simply confirm what is already known in this area. If the OLS estimates are used, the implied elasticity of wages with respect to rents is higher than most other estimates, but not remarkably so. In terms of the test proposed in this paper, if the instrumental variables estimates are discounted, the evidence would support an efficiency wage interpretation of the data.

As the dataset used here is for a developing country none of the results are inconsistent with any of the above studies, which all use UK or US data. The evidence from other developing countries is limited. A study by Moll (1993) compared results from South Africa on industry wage differentials with those for the US. His data did not allow a direct test as no firm level profits data was available. Similarly a study by Morrison (1994), which argues against a rent-sharing interpretation of wage determination in Ecuador, does not have firm level information on profits. The variance of this variable is so large as to render suspect any inferences about rent-sharing where profits cannot be observed.

In some respects there is remarkable similarly between economies as diverse as those of the UK, the US and Ghana. In particular the importance of the relative wage term is common to all the studies, as is the major change in the parameter estimates which occur if instruments are used. The major difference is that most research on UK and US data suggests that rent sharing effects cannot be identified in non-unionised sectors of the market. The contrary result reported here either reflects inadequacies in the data, or estimation, or a genuine difference across the economies. The test carried out here has not been reported for any of the studies cited so, in principle, it should be possible to narrow down whether this form of market imperfection is more important in developing than in developed country labour markets.

6. Summary and Conclusions

The use of relative wage terms in a productivity equation has been used to test for efficiency wages. The efficiency wage hypothesis predicts a parameter value equal to the labour share in a constant returns to scale Cobb-Douglas production function. In this paper the implications of rent sharing for the size of this parameter have been presented. The rent-sharing hypothesis predicts a coefficient value which is the inverse of the elasticity of relative wages with respect to rent sharing. This comparative test has been carried out and it been shown that the result hinges on the validity of the instruments. If the instruments used in this paper are correctly capturing an exogenous change to profits, then the evidence strongly supports the rent-sharing interpretation of the data.

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Table 1: The Data

	Value-added per Employee Cedis	**Capital Labour Ratio Cedis**	**Profits per Employee Cedis**	**Relative Wage**(a)
Wave 1				
[N=85]	817,336	2,332,676	613,693	1.19
	[1,273,844]	[4,740,188]	[1,159,801]	[0.79]
Wave 2				
[N=101]	1,099,894	2,991,407	849,925	1.06
	[1,496,437]	[5,634,497]	[1,390,273]	[0.70]
Wave 3				
[N=91]	1,110,783	5,669,115	745,166	1.15
	[1,363,290]	[9,940,770]	[1,163,709]	[0.64]

(a) Relative wage is the Actual average wage in the firm as a ratio of the predicted wage.

N is the number of observation. Figures in [ ] are standard deviations.

Table 2: The Production Function

Dependent Variable: Ln (Value-added)

	Level Equation (a)	**Differenced Equation**
Constant	8.91	0.23
	[9.16]	[1.5]
Age	0.08	0.02
	[1.31]	[0.2]
Age^2	-0.001	-0.00005
	[1.2]	[0.0]
Education	0.04	0.01
(in years)	[1.81]	[0.1]
Tenure	0.04	-0.003
	[2.33]	[0.1]
Ln (Labour)	0.84	0.54
	[8.6]	[2.0]
Ln (Capital)	0.16	-0.07
	[3.8]	[0.9]
Wave2	0.19	
	[1.3]	
Wave3	0.24	
	[1.4]	
Wave dummy		-0.13
		[0.6]
Adjusted R^2	0.77	0.003
F (DF) (b)	1.94 (3,252)	
F (DF) (c)	0.58 (38,217)	
χ^2 (White test) (DF) (d)	200.0 (184)	24.9 (34)
Number of Obs.	277	147

(a) The controls in this equation are location, sector, ownership and unionisation.
(b) This F statistic is a test for including the squared terms in capital and labour and the interaction term. The test accepts the hypotheses that these terms can be excluded from the equation.
(c) This F statistic is a test for pooling the three waves of the data. The hypothesis that the data pools is accepted.
(d) The White test accepts the null of homoscedastic errors for both the regressions.
The absolute value of t statistics, which have been corrected by the method due to White (1980), are in [ ] parentheses. The equations were estimated using LIMDEP, Greene (1992).

Table 3: The Determinants of Firm Productivity and Relative Wages Ordinary Least Squares Estimates (OLS)

Dependent Variable	**Ln (Value-added /Employee)**		**Ln (Relative Wage)**	
	Levels Equation (a)	Differenced Equation	Levels Equation (a)	Differenced Equation
Constant	8.72	0.26	-0.23	-0.09
	[9.1]	[1.8]	[0.4]	[0.9]
Age	0.08	0.02	-0.01	-0.02
	[1.4]	[0.2]	[2.3]	[0.4]
Age^2	-0.001	0.00	0.00005	0.0001
	[1.2]	[0.0]	[0.12]	[0.2]
Education (in years)	0.057	0.02	-0.03	-0.02
	[2.2]	[0.3]	[2.1]	[1.1]
Tenure	0.03	0.00	0.01	-0.02
	[1.9]	[0.01]	[0.9]	[1.0]
Ln (Labour)	-0.05	-0.50	0.11	0.08
	[0.6]	[1.7]	[2.9]	[0.5]
Ln (Profits per Employee)			0.07	0.11
			[3.0]	[3.6]
Ln (Relative wage)	0.49	0.45		
	[4.3]	[2.8]		
Ln (Capital/ labour ratio)	0.16	-0.05	-0.02	-0.02
	[3.9]	[0.8]	[0.9]	[0.4]
Wave2	0.23		-0.09	
	[1.6]		[1.1]	
Wave3	0.22		0.02	
	[1.3]		[0.2]	
Wave dummy		-0.21		0.17
		[1.0]		[1.5]
Adjusted R^2	0.41	0.04	0.20	0.05
χ^2 (White test) (DF) (b)	208 (202)	25.7 (43)	186.7 (202)	37.4 (43)
Number of Obs.	277	147	277	124

(a) The controls in these equations are sector, location, ownership and unionisation.
(b) The White test accepts the null of homoscedastic errors for all the regressions.
The absolute value of t statistics, which have been corrected by the method due to White (1980), are in [ ] parentheses. The equations were estimated using LIMDEP, Greene (1992).

Table 4: The Determinants of Firm Productivity and Relative Wages Instrumental Variable Estimates (IV) (a)

Dependent Variable	**Ln (Value-added /Employee)**		**Ln (Relative Wage)**	
	Levels Equation (b)	Differenced Equation	Levels Equation (b)	Differenced Equation
Constant	7.67	0.56	-1.64	-0.09
	[4.4]	[1.2]	[2.1]	[1.0]
Age	0.09	0.005	-0.02	-0.01
	[1.0]	[0.0]	[0.6]	[0.2]
Age^2	-0.001	0.001	0.0002	-0.00002
	[0.7]	[0.3]	[0.5]	[0.03]
Education	0.13	0.11	-0.05	-0.03
(in years)	[2.2]	[1.0]	[2.5]	[1.3]
Tenure	-0.004	0.04	0.0002	-0.02
	[0.1]	[0.5]	[0.02]	[1.3]
Ln (Labour)	-0.3	-0.26	0.12	0.09
	[2.3]	[0.3]	[2.6]	[0.6]
Ln (Profits per			0.24	0.17
Employee)			[3.5]	[2.7]
Ln (Relative	3.2	5.4		
wage)	[4.0]	[2.5]		
Ln (Capital/	0.19	0.08	-0.05	-0.02
labour ratio)	[2.5]	[0.3]	[1.7]	[0.3]
Wave2	0.43		-0.13	
	[1.6]		[1.4]	
Wave3	0.11		-0.02	
	[0.4]		[0.2]	
Wave Dummy		-1.05		0.17
		[1.6]		[1.5]
Adjusted R^2	0.14	-0.02	0.16	0.03
Sargan test (DF) (c)	0.03 (1)	0.004 (1)	0.02 (1)	0.06 (1)
Number of Obs.	277	147	277	124

(a) The instruments used are the share of intermediate costs in total output and the amount of formal borrowing per employee.
(b) The controls in these equations are sector, location, ownership and unionisation.
(c) The Sargan test accepts the validity of the instruments for all the equations.
The absolute value of t statistics, which have been corrected by the method due to White (1980), are in [ ] parentheses.

Appendix of Variable Definitions

The human capital variables that are used in the firm level regressions are based on a worker survey that was carried out as the same time as the firm interview. A representative sample of workers from each firm was asked questions relating to their age, education, training and background. The average of the answers to those questions is used to construct the following variables:

Human Capital Variable Definitions:

Age	The age of the worker.
Age^2	The age of the worker squared.
Education	The education of the worker in years. This variable was constructed from answers as to the final stage of school or university completed. It is treated as a continuous variable although we cannot measure years of education from this data set quite that precisely.
Tenure	Years in current job.

Firm Characteristics:

Labour	This is the number of full time employees in the firm.
Capital	This is the reported value of the replacement capital stock.
Profits per Employee	The profits per employee for the firm. This variable was calculated by taking sales revenue less wages less intermediate inputs and indirect costs. There is no allowance for depreciation.
Union	Dummy variable =1 if firm has any union members.

Firm characteristics for which controls were used but not reported in Tables:

State	Dummy =1 for some State Ownership (if the firm had both state and foreign ownership it was placed in the FOR category)
For	Dummy =1 for any Foreign Ownership. The omitted category is thus firms with solely Ghanaian owners.

The location dummies included in the regressions are:

KUM	Dummy variable = 1 for workers living in Kumasi
TAK	Dummy variable = 1 for workers living in Takoradi
CAPE	Dummy variable = 1 for workers living in Cape Coast

The sector dummies included in the regressions are:

FOODS	Dummy = 1 for Food Sector
BAKERY	Dummy = 1 for Bakery
WOOD	Dummy = 1 for Wood Sector
FURN	Dummy = 1 for Furniture Sector
METAL	Dummy = 1 for Metal Sector
MACHINES	Dummy = 1 for Machine Sector

Instruments:

Formal Borrowing per employee
This variable is the sum of all the formal sector borrowing of the firm, ie borrowing from banks and other formal sector institutions.
Share of Intermediate costs in the value of total output. Intermediate costs include material and indirect costs.